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NATIONAL DAM SAFETY PROGRAM. SPRING LAKE DAM (MO 10136), GRAND --ETC(U)  
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GRAND CHARITON RIVER BASIN

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SPRING LAKE DAM  
ADAIR COUNTY, MISSOURI  
MO. 10136

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM



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DEPARTMENT OF THE ARMY  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
210 NORTH 12TH STREET  
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Spring Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Spring Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure
- 3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED 31 MAR 1980  
Chief, Engineering Division Date

APPROVED BY: SIGNED 1 APR 1980  
Colonel, CE, District Engineer Date

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SPRING LAKE DAM  
ADAIR COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10136

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

PREPARED BY  
CONSOER, TOWNSEND AND ASSOCIATES, LTD.  
ST. LOUIS, MISSOURI  
AND  
ENGINEERING CONSULTANTS, INC.  
ENGLEWOOD, COLORADO  
A JOINT VENTURE

UNDER DIRECTION OF  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
FOR  
GOVERNOR OF MISSOURI

DECEMBER 1979

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Spring Lake Dam, Missouri Inv. No. 10136  
State Located: Missouri  
County Located: Adair  
Stream: Elm Creek  
Date of Inspection: August 22, 1979

Assessment of General Condition

Spring Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and State agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends approximately five miles downstream of the dam. Within the damage zone are the communities of Yarrow and Gifford and a dwelling and building along Chariton River between the two communities which may

be subjected to flooding, with possible damage and/or destruction and possible loss of life. Spring Lake Dam is in the intermediate size classification since it is less than 40 feet high but impounds more than 1,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of Spring Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Spring Lake Dam being an intermediate size dam with a high hazard potential is required by the guidelines to pass the Probable Maximum Flood without overtopping. It was determined that the reservoir/spillway system can accommodate 24 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation also indicates that the reservoir/spillway system can accommodate the 100-year flood without overtopping.

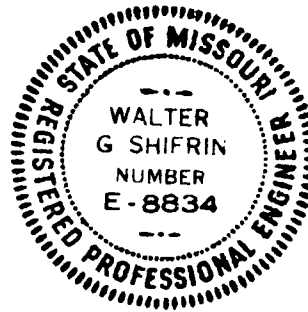
The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. The 100-year flood is defined as a flood having a one percent chance of being equalled or exceeded during any given year.

Other deficiencies noted by the inspection were: the trees and cattails in the spillway; the small trees on the downstream slope; the erosion due to wave action on the upstream slope; the depression at the toe of the dam created by the discharge through the outlet works; the erosion on the left side of the downstream channel; a need for periodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.



It is recommended that the owner take action to correct  
or control the deficiencies described above.

*Walter G. Shifrin*  
Walter G. Shifrin, P.E.





Overview of Spring Lake Dam

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

SPRING LAKE DAM, I.D. No. 10136

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

SPRING LAKE DAM, Missouri Inv. No. 10136

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Spring Lake Dam was carried out under Contract DACW 43-79-C-0075 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Spring Lake Dam was made on August 22, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, presents an assessment as to the structural adequacy of the various project features and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the south abutment or side, and right to the north abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in the publication "Recommended Guidelines for Safety Inspection of Dams," Appendix D. These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations and private engineers.

1.2

Description of the Project

a. Description of Dam and Appurtenances

It should be noted that a trustee of the dam, Mr. Ralph Shane of Kirksville, Missouri, has indicated he has a set of plans pertaining to Spring Lake Dam. However, Mr. Shane has not been able to locate the plans for use in this report. The following description of the dam and appurtenant structures is based exclusively upon observations and measurements made during the visual inspection.

The dam is an earthfill structure. The crest of the embankment has a width of 27 feet and length of approximately 863 feet. The crest elevation is approximately 772 feet above MSL, and the maximum height of the embankment is 25 feet.

The upstream slope of the embankment is protected by riprap and is nearly vertical from the crest to the water surface. The downstream slope was measured as 1V to 2.5H from the crest to the toe of the dam.

The spillway for Spring Lake Dam is a cut into the right abutment. The spillway is a trapezoidal shaped, uncontrolled open channel. The control section has a bottom width of 87 feet and is 4.5 feet high to the top of the dam. The sides of the channel are sloped at 1V to 1H. The spillway channel is approximately 100 feet in length. A concrete slab is provided on the control section of the spillway.



A low-level drain was provided for Spring Lake Dam. The drain consists of two 12-inch diameter cast iron pipes. Each pipe is controlled by a separate gate valve. Both of the valves are located in a valve house at the toe of the dam approximately 20 feet upstream from the downstream end of the pipes. The drain pipes are located approximately 150 feet to the right of the left abutment. The ends of the pipes are approximately 6 feet apart.

b. Location

Spring Lake Dam is located on Elm Creek approximately 0.4 miles upstream from the confluence of Elm Creek and the Chariton River. The community of Yarrow is approximately 0.5 miles to the south of the damsite. The dam is located in the Section 10, Township 61 North, Range 16 West on the Kirksville, Missouri, Quadrangle Sheet (15 minute series).

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam-size category as being "Intermediate" since its storage is more than 1,000 acre-feet but less than 50,000 acre-feet. The dam is classified as "Small" in the dam-size category because its height is less than 40 feet. The overall size classification is "Intermediate" in size.

d. Hazard Classification

The dam has been classified as having a "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. Within the estimated damage zone, which extends approximately five miles downstream of the dam, are the two small communities of Yarrow and Gifford, and a dwelling and building along the Chariton River between the two communities.

e. Ownership

The Spring Lake Dam is owned privately by Spring Lake, Inc. The mailing address is Spring Lake, Inc., c/o James M. Rolston, Box 190, Kirksville, Missouri 63501.

f. Purpose of Dam

The main purpose of the dam is to impound water for recreational use.

g. Design and Construction History

Spring Lake Dam was designed by J.W. Shikles and Company, Kansas City, Missouri, in 1947-48.

Originally, and up until three years ago, according to Mr. James Rolston, a trustee of Spring Lake, the primary purpose of the dam was for domestic water storage. Since 1976, the lake has been used primarily for recreational purposes.

#### h. Normal Operational Procedures

Normal procedure is to allow the lake to remain as full as possible. The water level below the spillway crest is controlled by rainfall, runoff and evaporation. The reservoir is equipped with a low-level outlet, but according to Mr. James Rolston, a trustee of Spring Lake, the valves to the drain system have not been operated in the last six or seven years.

1.3      Pertinent Data

a. Drainage Area (square miles):	2.88
b. Discharge at Damsite	
Estimated experienced maximum flood (cfs):	NA
Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs)	2,650
c. Elevation (feet above MSL)	
Top of dam:	772
Spillway crest:	767.5
Normal Pool:	767.5
Maximum Pool (PMF):	775.43
d. Reservoir	
Length of pool with water surface at top of dam elevation (feet):	4,170
e. Storage (Acre-Feet)	
Top of dam:	1,078
Spillway crest:	740
Normal Pool:	740
Maximum Pool (PMF):	1,429
f. Reservoir Surfaces (Acres)	
Top of dam:	84
Spillway crest:	70.5
Normal Pool:	70.5
Maximum Pool (PMF):	118
g. Dam	
Type:	Earthfill

Length:	863 feet
Structural Height:	25 feet
Hydraulic Height:	25 feet
Top width:	27 feet
Side slopes:	
Downstream	1V to 2.5H
Upstream	Near Vertical (crest to water surface)
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel	None
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i. Spillway

Type:	Trapezoidal open channel, uncontrolled
Length of crest:	87 feet
Crest Elevation (feet above MSL):	767.5

j. Regulating Outlets

Type:	Two, 12-inch diameter low-level drains
Length:	Unknown
Closure:	Two gate valves
Maximum Capacity:	Unknown

## SECTION 2: ENGINEERING DATA

### 2.1 Design

A trustee of the dam, Mr. Ralph Shane of Kirksville, Missouri, has indicated that he has a complete set of plans pertaining to Spring Lake Dam; however, he has not been able to locate the plans for use in this report.

### 2.2 Construction

No construction data are available for the dam and appurtenant structures. In addition, no data were available regarding the reconstruction to control seepage near the left abutment.

### 2.3 Operation

No operation records are available for Spring Lake Dam.

### 2.4 Evaluation

#### a. Availability

The availability of engineering data is poor and consists only of state geological maps and U.S.G.S. quadrangle sheets. No information on design hydrology or hydraulic design was available.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily upon visual inspection, past performance history and sound engineering judgment.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions including Earthquake Loads and made a matter of record.

c. Validity

No valid engineering data are available.

### SECTION 3: VISUAL INSPECTION

#### 3.1 Findings

##### a. General

A visual inspection of the Spring Lake Dam was made on August 22, 1979. The dam generally is in satisfactory condition. The following persons were present during the inspection:

<u>Name</u>	<u>Affiliation</u>	<u>Disciplines</u>
Dr. M.A. Samad	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark R. Haynes	Engineering Consultants, Inc.	Civil, Structural and Mechanical
Dawn L. Jacoby	Engineering Consultants, Inc.	Soils
Peter L. Strauss	Engineering Consultants, Inc.	Geology
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Jim Rolston	Spring Lake, Inc.	Board Member

Specific observations are discussed below.



b. Dam

The crest of the dam supports a well-maintained gravel road with cut grass on each side. No deviations in horizontal or vertical alignment were apparent. No settlements or bulges were observed. To the best of Mr. Rolston's knowledge, the dam has never been overtopped and there was no evidence indicating the contrary.

The upstream slope was protected partially from erosion by riprap with a maximum size of 36 inches. The upper section of the slope was covered by grass and bushes. Some erosion due to wave action is occurring above the riprap, which has steepened the slope above the riprap to near vertical. No bulges or depressions were observed. There was no evidence of rodent activity.

The downstream slope is covered by grass and weeds. Several small trees are growing along the slope. No bulges or depressions were observed. No cracks or signs of instability were apparent. No seepage was observed on the slope or downstream of the toe.

No data are available indicating the type of material used for construction of the embankment. Material taken from below the topsoil on the embankment was a silty clay.

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Weller-Keswick-Lindley-Mandeville in the Central Mississippi Valley Wooded Slopes forest. These soils are formed basically from loess, glacial till and

weathered shale. The permeability of these soils range from slow to moderate and erodability is quite high.

c. Project Geology

The damsite physiographically is located in the Dissected Till Plains Section of the central lowlands Physiographic Province, according to Nevin Fenneman's "Physiography of the Eastern United States." This section is distinguished from the Till Plains on the east and from the Young Drift section on the north by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain, submature in its erosion cycle.

No faults have been identified in the project vicinity.

Approximately 12 miles to the southwest of the damsite lies the trace of the Macon-Sullivan Trough that had its last movement in post-Ordovician time. This minor structure has no effect on the dam.

The site bedrock geology, beneath the drift, as shown on the Geologic Map of Missouri (1979), is interbedded Pennsylvanian age shales, limestones and sandstones. These strata generally strike north-south and dip gently to the west.

The left abutment of the dam is in contact with thin tightly bedded, gray fossiliferous limestone. This rock was hard, dense and stable.

A small drainage creek runs behind the left abutment and below the toe of the dam. This small creek is well channelized in rock behind the left abutment.

The downstream channel contains interbedded sandstones, limestones and calcareous shales. The bedding is nearly horizontal but somewhat undulatory. A sandstone cap about 2.5 feet thick overlies about 6 feet of argillaceous limestone/sandstone. The upper four feet of the limestone is fissile and soft. The lower two feet contain somewhat more sand and are micaceous. These lower two feet could be classified as an argillaceous sandstone.

The downstream channel appeared to be man made. A number of large sandstone pieces from the cap are lying in the channel as a result of being undermined by the eroding fissile limestone. The channel appears to be relatively stable.

From the surrounding evidence, it is assumed the dam is founded on bedrock.

#### d. Appurtenant Structures

##### (1) Spillway

The spillway is an excavated channel on the right abutment. The channel is excavated to bedrock. The spillway is obstructed by cattails and a few trees. The right side slope of the spillway channel appears to be stable and is adequately protected from surface erosion by a heavy grass cover. The left side slope is a constructed berm that channelizes discharges through the spillway away from the downstream slope of the embankment. The slope is protected by rock masonry and appears to be stable.

The road along the dam crest passes across the spillway channel. The road comes down the crest near the right abutment, passes through the spillway and then goes up the right abutment. A portion of the road is a concrete slab, 18 feet wide and 122 feet long, placed in the spillway channel. The slab appeared to be stable, however, a few temperature cracks were observed.

## (2) Outlet Works

The outlet works for Spring Lake Dam consists of two 12-inch cast iron low-level drain pipes. The discharge through the pipes is controlled by individual gate valves located in a valve house at the toe of the dam. It is unknown whether the valves are operable. The valves were inaccessible for manual operation on the day of the inspection due to a locked door. The intake of the drain was inaccessible due to the reservoir level. No seepage was observed in or around the pipes.

Discharges through the pipes have created a depression just downstream of the outlets that has started to undercut the pipes. The last 12 feet of the drain pipes appeared to have been originally 12-inch corrugated metal pipes. It appears that discharges through the pipes must have undercut the two C.M. pipes eventually causing them to collapse. The two C.M. pipes are still lying below the two cast iron pipes.

e. Reservoir Area

The water surface elevation was 767.2 feet above MSL on the day of the inspection.

The reservoir rim is sloped gently and no indication of instability or severe erosion was readily apparent. The slopes above the reservoir are wooded and grass covered. Several homes are built around the reservoir rim.

f. Downstream Channel

The downstream channel of the spillway is a rock cut channel having a bottom width of approximately 15 feet and side slopes of 1V to 0.5H. The channel widens out into a grass-lined channel. The channel is unobstructed. The channel has been eroded on the left side.

3.2 Evaluation

The visual inspection did not reveal any items that are sufficiently significant to indicate a need for immediate remedial action.

The following conditions were observed that could affect the safety of the dam or that will require maintenance within a reasonable period of time.

1. The wave erosion on the upstream slope, if allowed to continue, could affect the structural stability of the dam.

2. The small trees observed on the downstream slope do not jeopardize the safety of the embankment at their present stage of growth. Nevertheless, the trees should be removed from the embankment and not allowed to grow back. As the trees grow larger, the root systems also grow larger thus endangering the safety of the dam. The roots of the trees present possible paths for piping through the embankment. The root system could also damage the dam if a tree is uprooted by a storm.

3. The obstruction created by cattails and trees in the spillway poses a danger to the safety of the embankment. The obstruction decreases the capacity of the spillway, thus increases the potential of overtopping the dam. The cattails and trees should be removed and prevented from growing back.

4. The depression created by discharges through the low-level drain does not appear to affect the safety of the drain or the embankment of the dam in its present condition. Nevertheless, this condition should be monitored and if the erosion continues, steps should be taken to correct the situation.

5. The erosion on the left side in the downstream channel, if allowed to continue, would affect the stability of the side slope of the channel.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

Spring Lake Dam is used to impound water for recreational use. The lake is kept as full as possible at all times. According to Mr. Rolston, a trustee of Spring Lake, the water level does not fluctuate very much throughout the year.

### 4.2 Maintenance of Dam

The dam is maintained by several local residents and the trustees of Spring Lake Development. The dam crest is kept in exceptionally good condition due to the well-maintained 24-foot wide gravel road. The upstream and downstream slopes are kept fairly cleared of trees and dense vegetation. Mr. Rolston informed the inspection team that the vegetation in the spillway channel usually is cleaned out yearly but was overlooked this year.

### 4.3 Maintenance of Operating Facilities

The only operable facilities at the damsite consist of the two gate valves located in the valve house at the toe of the dam near the left abutment. Although the valves have not been operated in six or seven years, Mr. Rolston, a trustee, believes that the valves could be operated if needed.

4.4      Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect for this dam.

4.5      Evaluation

Generally speaking, the operation and maintenance for Spring Lake Dam is adequate. To improve the operational adequacy of the dam, the corrective measures outlined in this report should be initiated within a reasonable period of time.



## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

#### a. Design

The watershed area of the Spring Lake Dam upstream from the dam axis consists of approximately 1,846 acres. Most of the watershed area is wooded and covered with grass. Land gradients in the higher regions of the watershed average roughly 12 percent, and in the lower areas surrounding the reservoir average about 20 percent. Spring Lake Dam Reservoir is located on Elm Creek and the Chariton River. At its longest arm, the watershed is approximately 1.5 miles long. A drainage map showing the watershed area is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Spring Lake Dam was based upon criteria set forth in the Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams," and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based upon criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The unit hydrograph parameters are presented in Appendix B. The

SCS method also was used for determining the loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are presented in Appendix B. The curve number, unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were directly input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak inflow of the PMF and one-half of the PMF are 19,737 cfs and 9,868 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. The reservoir was assumed at the spillway crest level at the start of the routing computation. The peak outflow discharges for the PMF and one-half of the PMF are 17,866 and 8,169 cfs, respectively. Both the PMF and one-half of the PMF when routed through the reservoir resulted in overtopping of the dam.

The size of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir stage-capacity data were based upon the U.S.G.S. Kirksville Quadrangle topographic map (15 minute series). The spillway and dam overtop-rating curve and the reservoir-capacity curve are presented as Plates 2 & 3, respectively, as Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erodable characteristics. The safe hydrologic design of an

embankment dam requires a spillway discharge capability, in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers design dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This generally is the accepted criterion for major dams throughout the world and is the standard for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1c(1) and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, both the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and one-half of the PMF are 17,866 and 8,169 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 2,650 cfs. The PMF overtopped the dam crest by 3.04 feet and one-half of the PMF overtopped by 1.48 feet. The total duration of embankment overflow is 5.58 hours

during the PMF and 2.83 hours during one-half of the PMF. The spillway/reservoir system of Spring Lake Dam is capable of accommodating a flood equal to approximately 24 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Spring Lake Dam will accommodate the 100-year flood without overtopping.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately five miles downstream of the dam. Within the damage zone are two small communities, Yarrow and Gifford, and a dwelling and building along Chariton River between the two communities.

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The crest is well protected by a gravel road. The downstream slope is protected by vegetation. The upstream slope has some riprap protection. The upstream slope is experiencing erosion due to wave action, which has steepened the slope above the water surface to near vertical. This condition is not serious at this time, but it should be monitored and the slope stabilized as required.

Overall, the spillway channel, the downstream channel and the low-level drain appear to be structurally stable. The exception is the erosion observed on the left side of the downstream channel. This erosion should be monitored and remedial measures undertaken as required.

#### b. Design and Construction Data

No design computations were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of

embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records were available relating to the stability of the dam or appurtenant structures. The water level on the day of the inspection was 4 inches below the crest of the spillway, and it is assumed that the reservoir remains close to full at all times.

d. Post Construction Changes

According to Mr. Rolston, prior to 1967, seepage was passing through cracks in the rock of the left abutment and exiting downstream of the dam to the left of the valve house. The reservoir was lowered and a trench was excavated into the abutment. The trench was then backfilled with impervious material, which stopped the seepage. No seepage has occurred since.

No other post construction changes exist that will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1, as defined in "Recommended Guidelines For Safety Inspection of Dams" prepared by the Corps of Engineers, and therefore, does not require a seismic stability analysis.

## SECTION 7: ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

#### a. Safety

The spillway capacity of Spring Lake Dam was found to be "Seriously Inadequate". The spillway/reservoir system will accommodate only 24 percent of the PMF without overtopping the dam. The PMF overtopped the dam by over three feet and the duration of embankment overflow is over 5-1/2 hours. If the body of the dam is made up of silty soils, the dam would be susceptible to erosion and failure during overtopping.

No quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record. The present embankment and appurtenant structures, however, reportedly have performed satisfactorily since their construction without failure or evidence of instability. Reportedly, the dam has never been overtopped and no evidence indicating the contrary was observed.

b. Adequacy of Information

Pertinent information relating to the design of the dam is lacking. The conclusions presented in this report are based upon field measurement, past performance and the present condition of the dam. Information on the design hydrology, hydraulic design, and the operation and maintenance of the dam were not available for review. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.



c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time. The items recommended in Paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

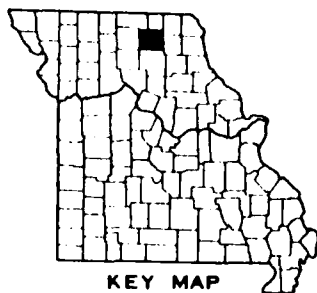
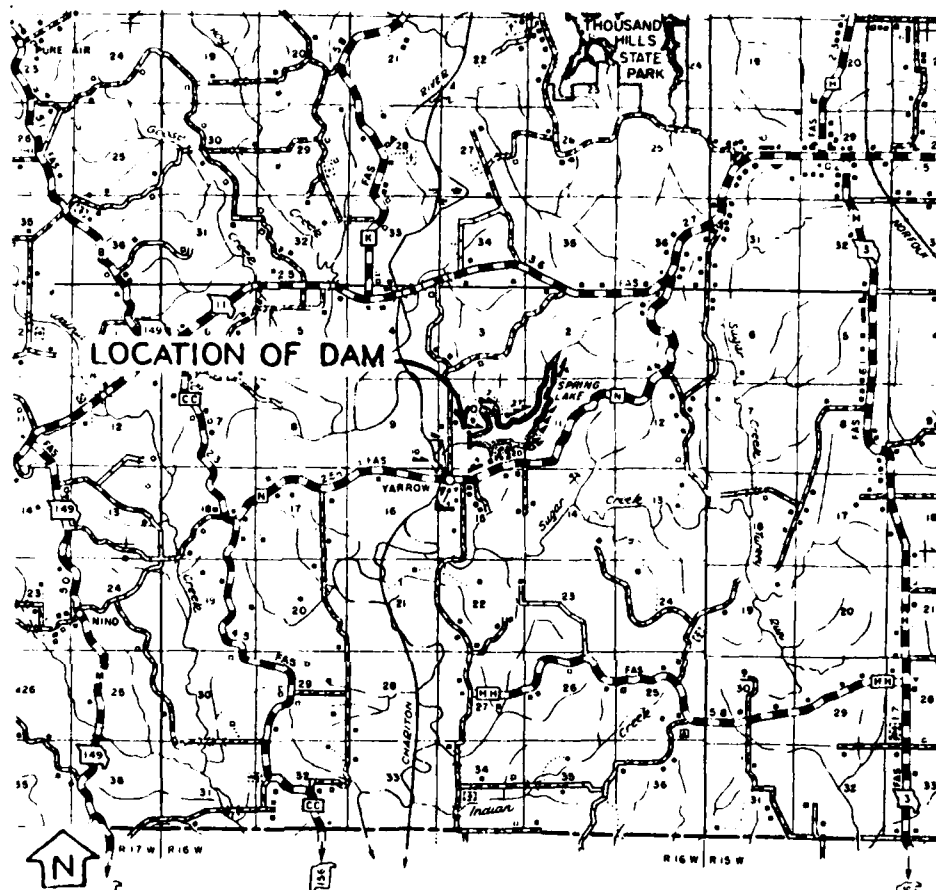
Spillway capacity and/or height of the dam should be increased to accommodate the PMF without overtopping the dam.

b. O & M Procedures

1. The trees and cattails in the spillway should be removed and prevented from growing back.
2. The small trees on the downstream slope should be removed and prevented from growing back.
3. Monitor the erosion due to wave action observed on the upstream slope.

4. Monitor the depression created by the discharge at the downstream end of the low-level drain.
5. Monitor the erosion on the left side of the downstream channel.
6. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.
7. The owner should initiate the following programs:
  - (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.
  - (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

PLATES



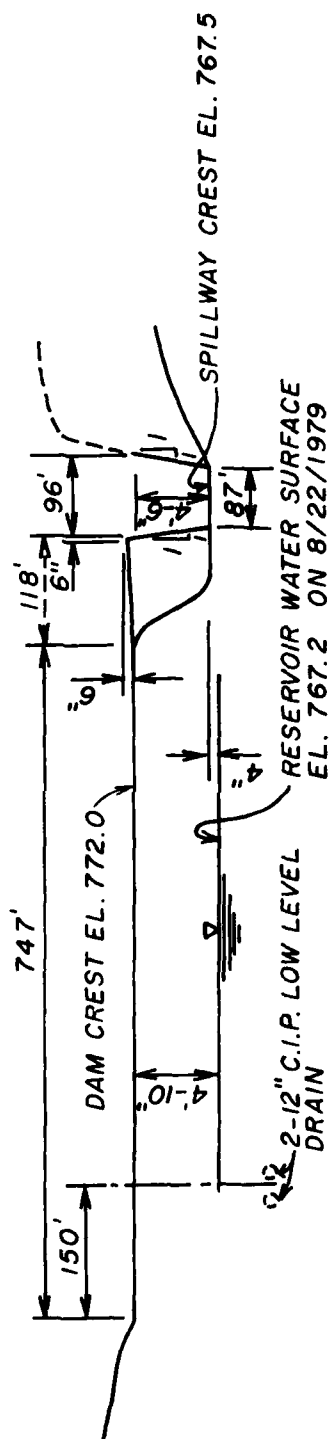
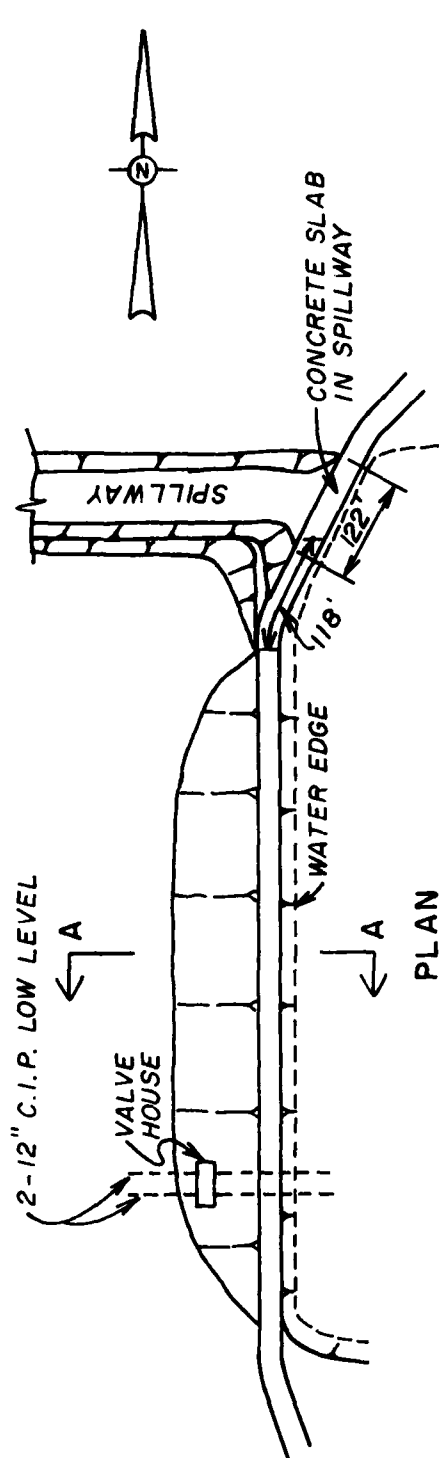
SHOWING LOCATION OF COUNTY

ADAIR COUNTY

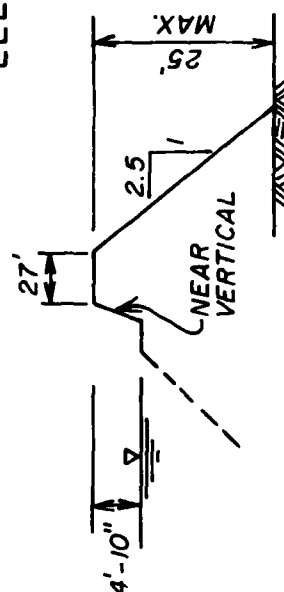
SCALE



LOCATION MAP - SPRING LAKE DAM



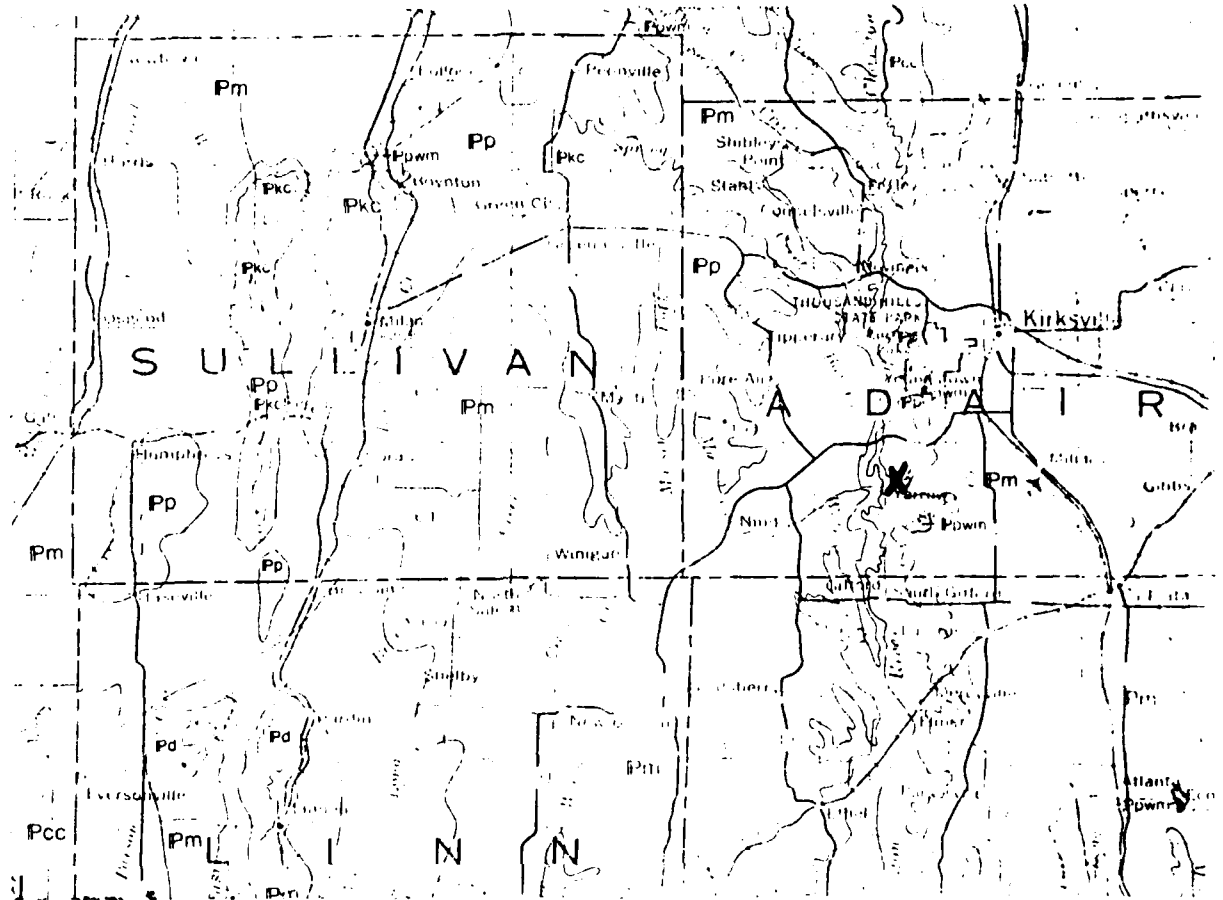
ELEVATION



SCALE  
1"=200' (HORIZONTAL)  
NO SCALE (VERTICAL)

SPRING LAKE DAM (MO. 10136)  
PLAN, ELEVATION & SECTION

# PLATE-3



PENNSYLVANIAN

{	IPpwm	} PLEASANTON GROUP
	IPp	
	IPm	- MARMATON GROUP
	IPcc	- CHEROKEE GROUP, CABANISS SUBGROUP

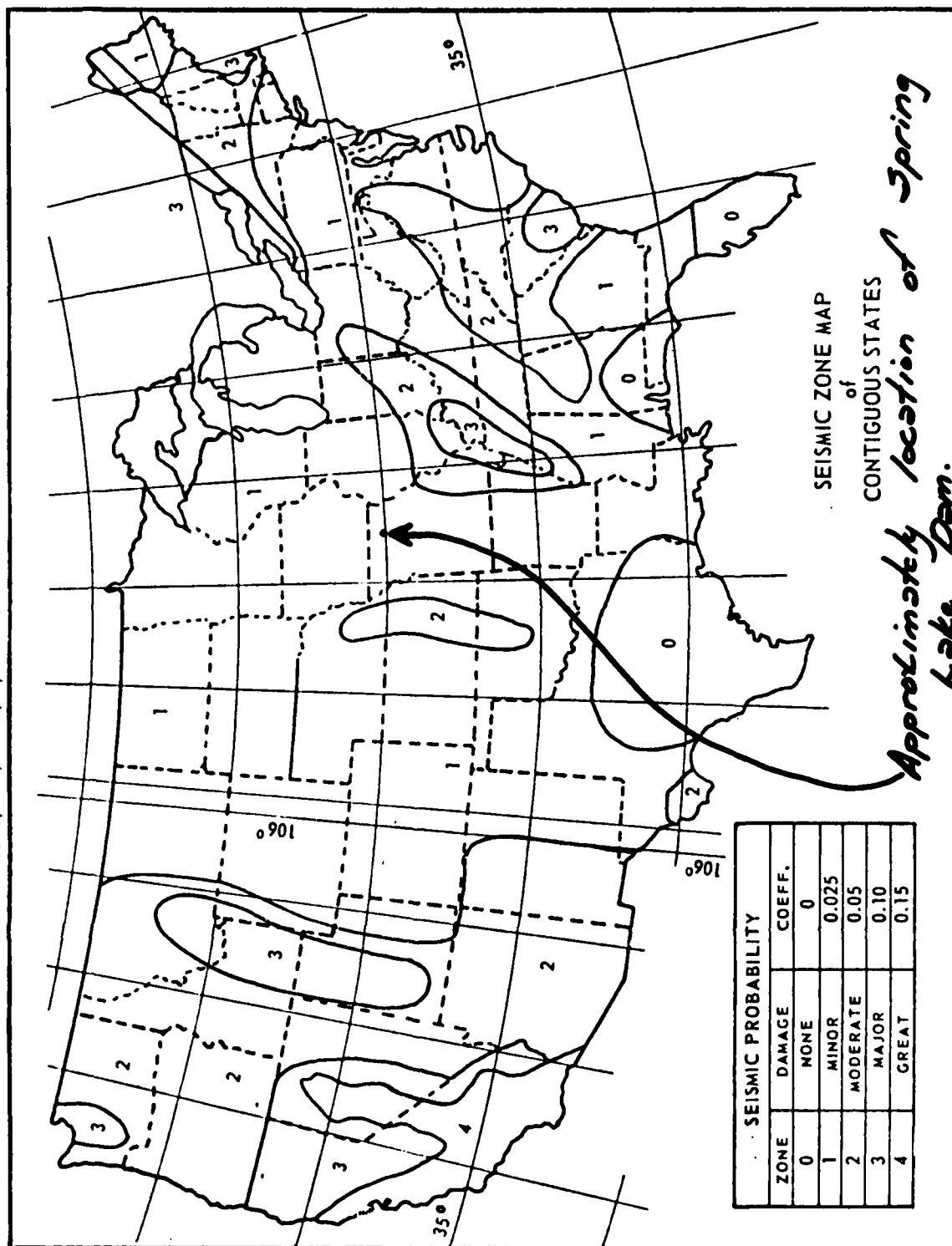
X - LOCATION OF DAM , MO. 10136

## REFERENCE:

GEOLOGIC MAP OF MISSOURI  
MISSOURI GEOLOGIC SURVEY  
1979

GEOLOGIC MAP  
OF  
ADAIR COUNTY  
AND  
ADJACENT AREA

From TM 5-809-10 NAVFAC P-355 AFM 88-3, Chapter 13, April 1973



APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION



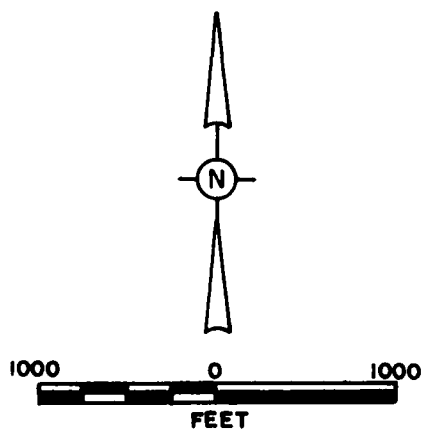
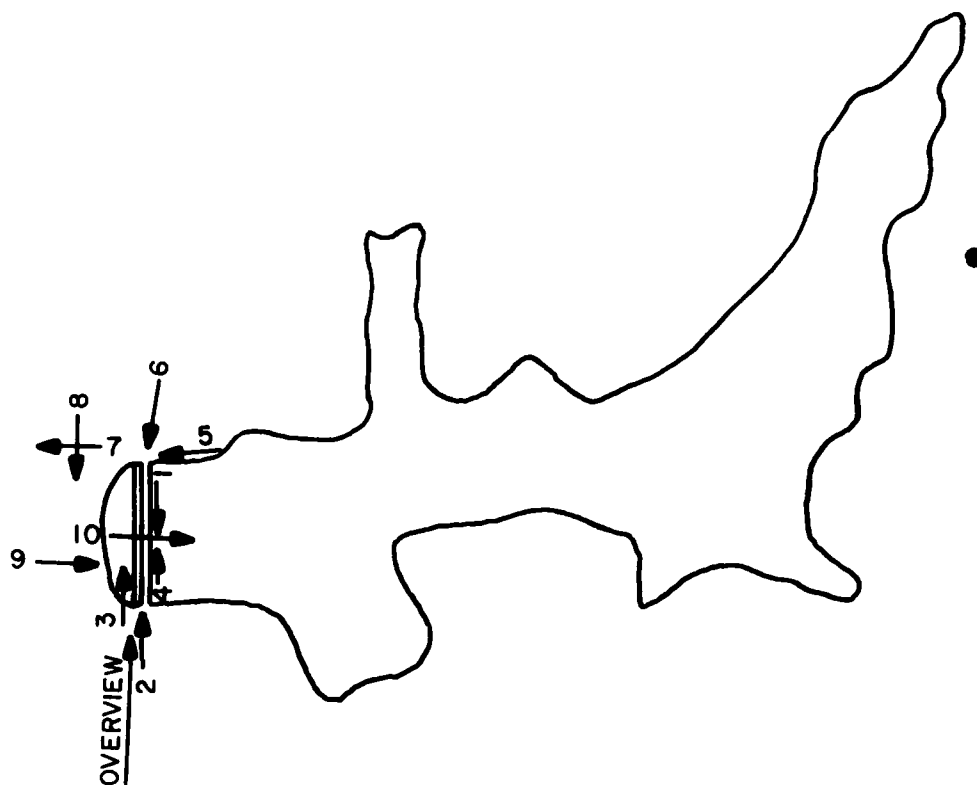


PHOTO INDEX  
FOR  
SPRING LAKE DAM

## Spring Lake Dam

- Photo 1. - View of the upstream slope of the embankment.
- Photo 2. - View of the crest.
- Photo 3. - View of the downstream slope of the embankment.
- Photo 4. - Closeup view of the riprap on the upstream slope.
- Photo 5. - View of the spillway from upstream.
- Photo 6. - View of the road through the spillway just upstream of the control section.
- Photo 7. - View of the downstream channel.
- Photo 8. - View of the stratification of the bedrock in the downstream channel.
- Photo 9. - View of the outlet of the low level drain.  
Note the valve house in the background.
- Photo 10. - View of the reservoir rim.

Spring Lake Dam



Photo 1



Photo 2

Spring Lake Dam



Photo 3



Photo 4

Spring Lake Dam



Photo 5



Photo 6

Spring Lake Dam



Photo 7

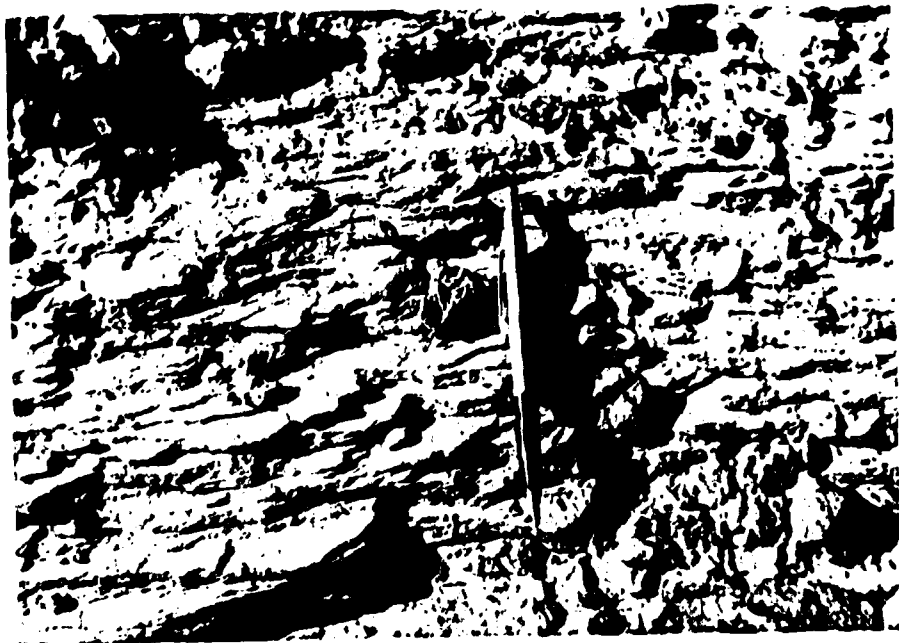


Photo 8

Spring Lake Dam



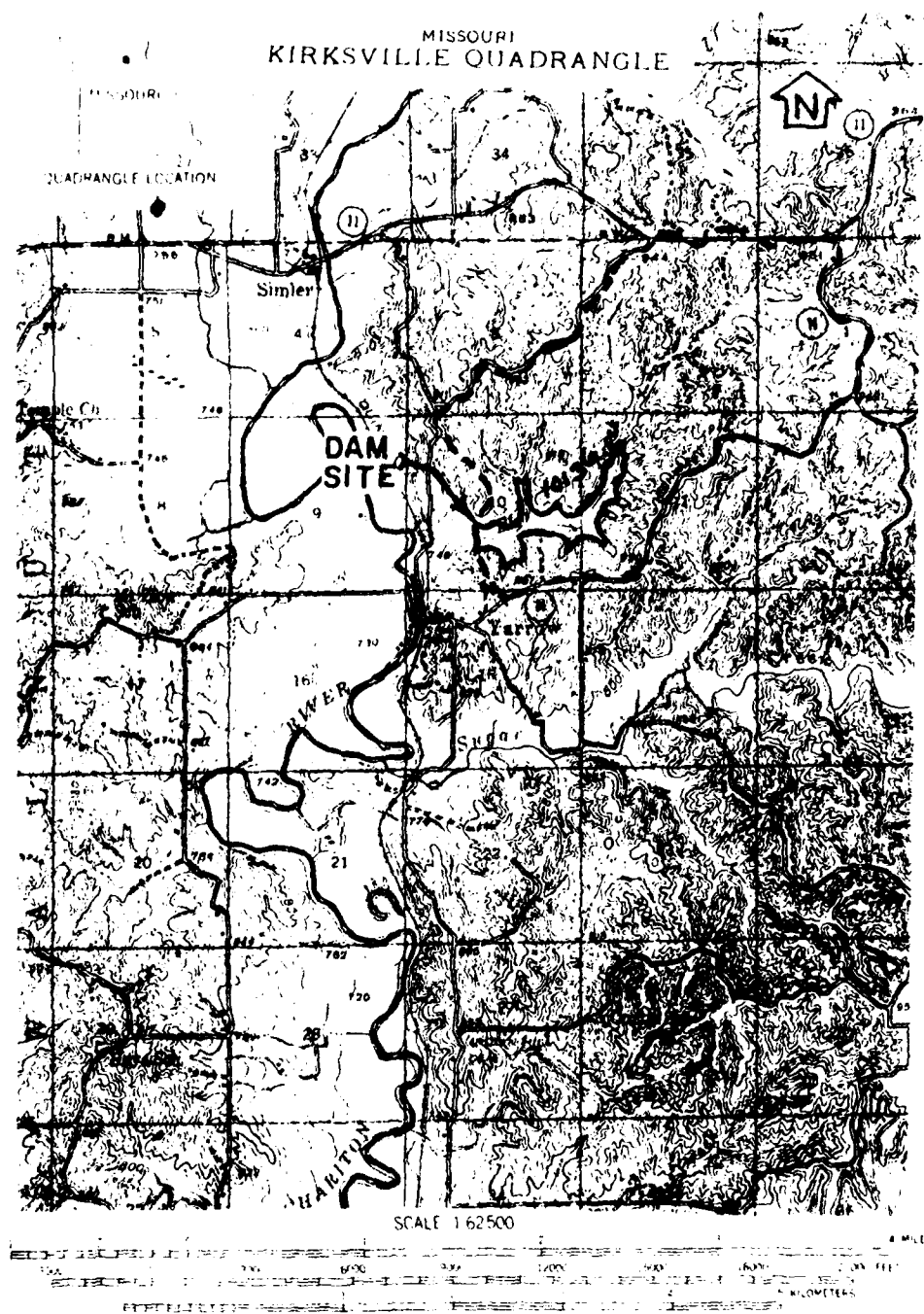
Photo 9



Photo 10

APPENDIX B  
HYDROLOGIC COMPUTATIONS





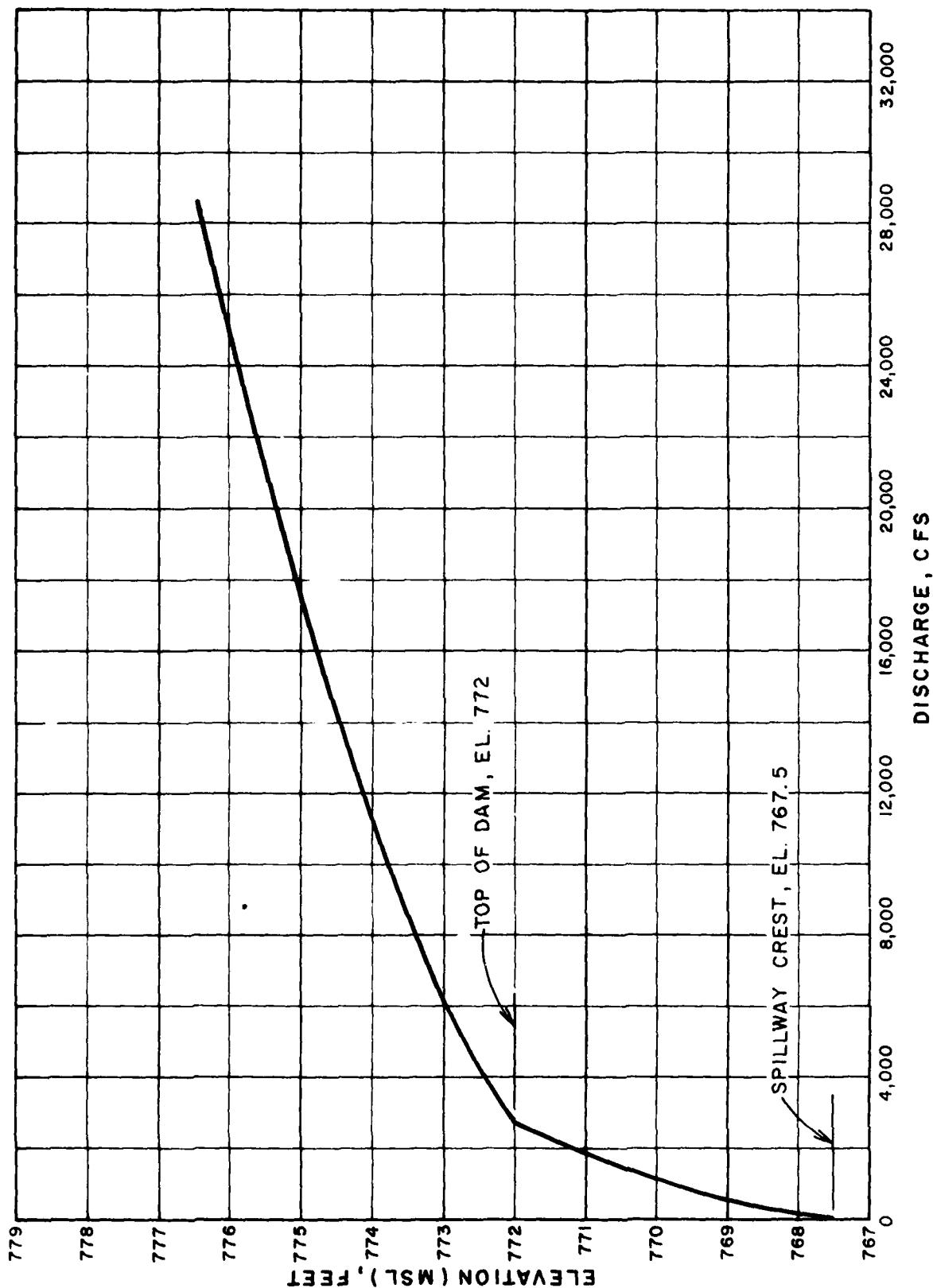
DRAINAGE BOUNDARY -----

SPRING LAKE DAM  
(MO 10136)

**B-2**

## DRAINAGE BASIN





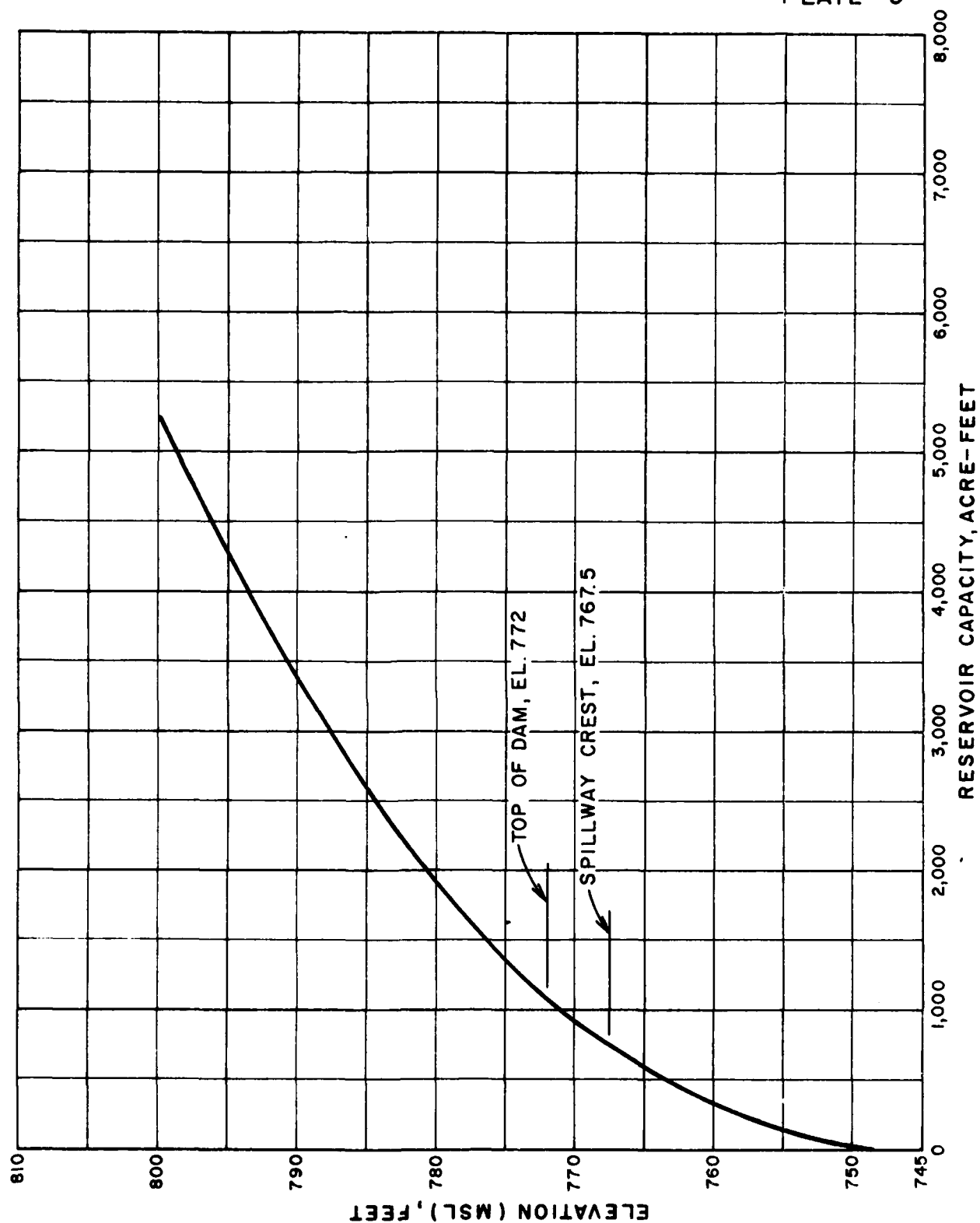
SPRING LAKE DAM (MO. 10136)  
 SPILLWAY & OVERTOP RATING CURVE  
 B-4

# ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1  
 SPRING LAKE DAM (10136) JOB NO. 1240-1  
 RESERVOIR AREA CAPACITY - DATA BY FRW DATE 7-13-7  
 KLB

## SPRING LAKE DAM 10136 RESERVOIR AREA CAPACITY

ELEVATION M.S.L. (FT.)	RESERVOIR SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC.FT)	TOTAL VOLUME (AC.FT)	REMARKS
740	0	-	0	ESTIMATED STREAMBED ELEVATION
750	14	9	9	
760	45.8	284	293	
767.5	70.5	433	726	SPILLWAY CREST
770	80	188	914	
772	84	164	1078	TOP OF DAM (assumed)
780	121.8	819	1897	
800	213.4	3309	5206	



SPRING LAKE DAM (MO. 10136)  
RESERVOIR CAPACITY CURVE

Dam Safety Inspection

SHEET NO. 1 OF

Missouri Dam # 10136

JOB NO. 1245-001-1

Research Maximum PMP P.A. 311

BY PRW ALB DATE 8-7-72

Dam # Mo. 10136

## DETERMINATION OF PMP

## 1) DETERMINE DRAINAGE AREA OF BASIN

D.A. = 1846 AC

2) DETERMINE PMP INDEX RAINFALL  
(200 SQ MI, 24 HR. DURATION)

## LOCATION OF CENTROID OF BASIN

LONG 92° 39' 29"

LAT. 40° 06' 47"

PMP INDEX  
RAINFALL = 24.1"

## 3) DETERMINE BASIN RAINFALL IN TERMS OF

PERCENTAGE OF PMP INDEX RAINFALL

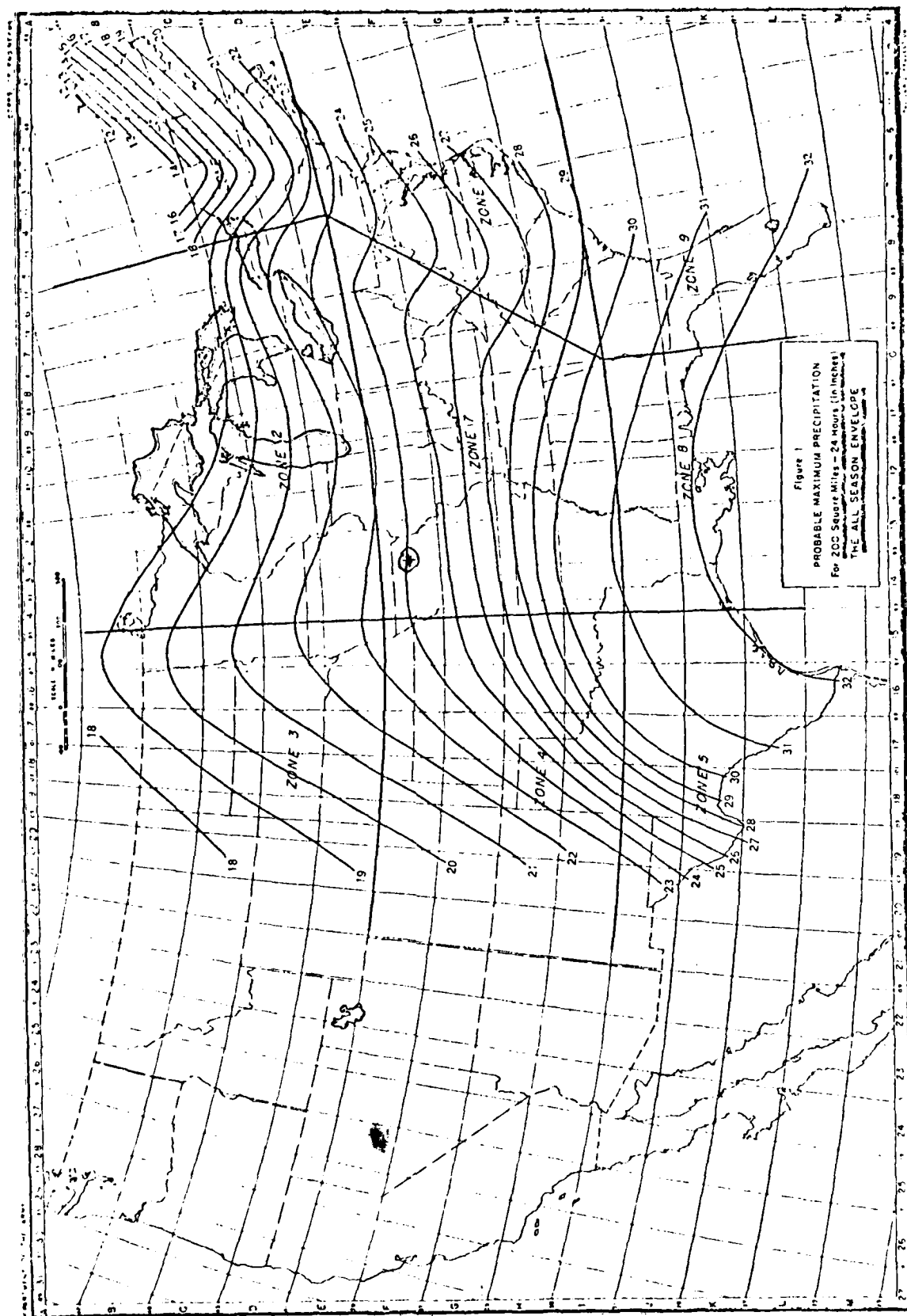
FOR VARIOUS DURATIONS:

LOCATION LONG 92° 39' 29"

LAT 40° 06' 47"

⇒ ZONE 7

DURATION (HR)	PERCENT OF INDEX RAINFALL	TOTAL RAINFALL (IN)	RAINFALL INCREMENTS	DURATION OF INCREMENTS
6	100	24.1	24.1	6
12	120	28.9	4.8	6
24	130	31.3	2.4	12



*Handwritten note:* 11.7. 11.7. 11.7.

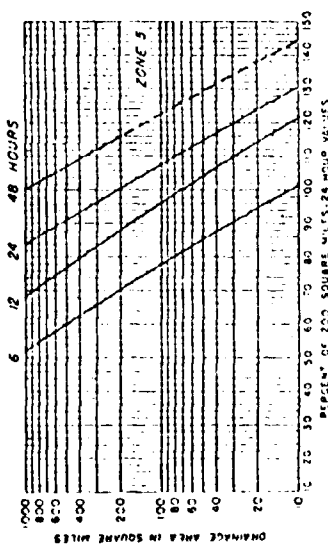
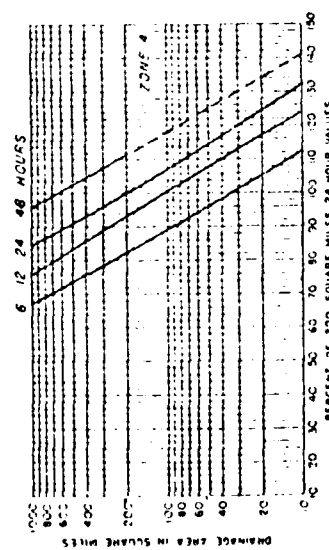
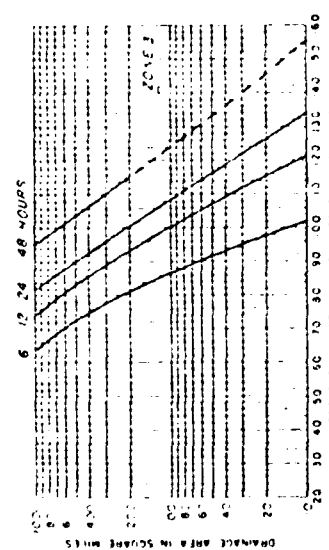
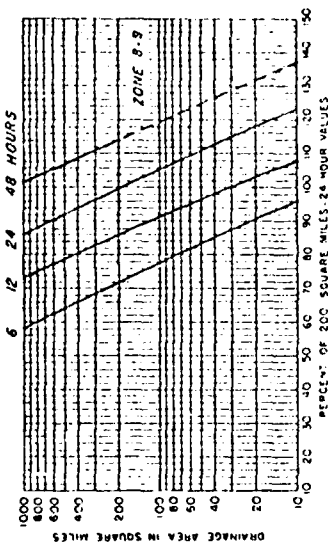
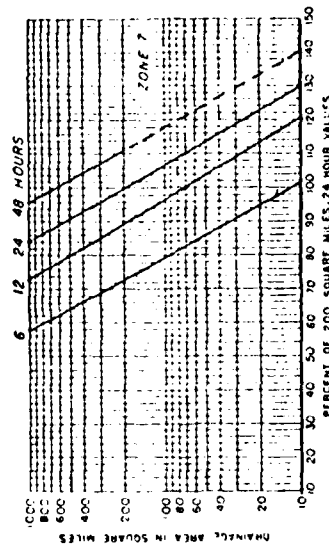
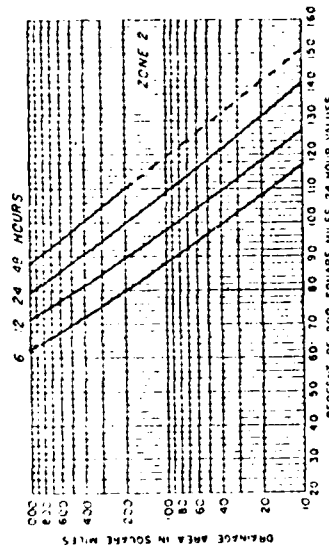
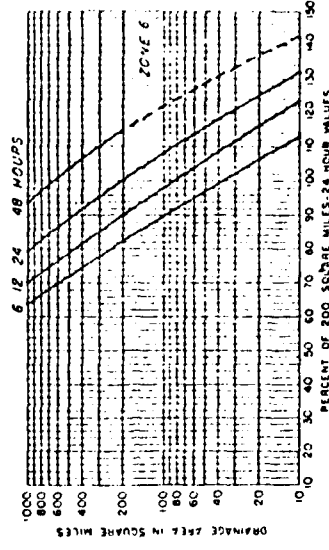
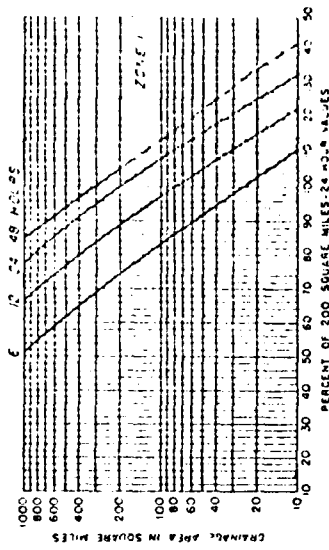


FIGURE 2  
SEASONAL VARIATION  
DEPTH-AREA-DURATION RELATIONSHIPS  
Percentage to be applied to 200 square miles  
24 hour probable maximum precipitation values  
for: THE-ALL SEASON ENVELOPE



DAM SAFETY INSPECTION / MISSOURI SHEET NO. 1 OF 1

SPRING LAKE DAM (1036) JOB NO. 1290-001

UNIT HYDROGRAPH PARAMETERS BY RHK DATE 4-6-79

1) DRAINAGE AREA = 1846 AC = 2.88 SQ. MI

2) LENGTH OF STREAM =  $L = (2.2 \times \frac{42500}{112}) = 11458 \text{ Ft} = \underline{2.17 \text{ mi}}$

3) ELEVATION OF DRAINAGE DIVIDE ALONG THE LONGEST STREAM  $H_1 = \underline{970 \text{ Ft}}$

4) RESERVOIR ELEVATION AT SPILLWAY CREST,  $H_2 = \underline{767.5 \text{ Ft}}$

5) DIFFERENCE IN ELEVATION =  $\Delta H = H_1 - H_2 = 970 - 767.5 = \underline{202.5 \text{ Ft}}$

6) SLOPE OF STREAM =  $\frac{H_{85} - H_{15}}{L} = \frac{960 - 770}{11458} = 0.0221 = \underline{2.21\%}$

7) TIME OF CONCENTRATION:

a) By KIRPICH FORMULA

$$T_c = \left( \frac{11.9 \times L^2}{\Delta H} \right)^{0.385} = \left( \frac{11.9 \times (2.17)^3}{202.5} \right)^{0.385} = \underline{0.82 \text{ hr.}}$$

b) BY VELOCITY ESTIMATE:

Slope of Stream =  $2.21\% \Rightarrow V = 3 \text{ FPS}$

$$T_c = \frac{L}{V} = \frac{11458}{3 \times 3600} = 1.06 \text{ HR}, \text{ USE } T_c = \underline{0.82 \text{ HR}}$$

8) LAG TIME =  $0.6 \times T_c = 0.6 \times 0.82 = \underline{0.49 \text{ HR}}$

9) UNIT DURATION  $D = \frac{L_t}{4} = \frac{0.49}{4} = \underline{0.123}$

USE  $D = 0.083 \text{ HR} = \underline{5 \text{ MIN}}$

10) TIME TO PEAK,  $T_p = \frac{D}{2} + L_t = \underline{0.53}$

11) PEAK DISCHARGE  $q_p = \frac{484 \times A}{T_p} = \frac{484 \times 2.88}{0.53}$

$$q_p = \underline{2630 \text{ CFS}}$$

## PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 1 OF

SPRING LAKE DAM (10136)

JOB NO. 1240-001-1

SOIL GROUP AND CURVE NUMBER DETERMINATION BY KLB

DATE 8-21-88

SPRING LAKE DAM (10136)HYDROLOGIC SOIL GROUP AND CURVE NUMBER

1. WATERSHED SOILS IN THIS BASIN CONSIST OF GROUP B, C, AND D SOILS. ASSUME GROUP C FOR HYDROLOGIC PURPOSES FOR THE ENTIRE WATERSHED.
2. THIS WATERSHED IS PRIMARILY FORESTED WITH ABOUT 20% IN RANGE AND PASTURE LAND. ASSUME THE HYDROLOGIC CONDITION OF THIS WATERSHED IS "FAIR".

THUS  $CN = 73$  (WOODS) 80% $CN = 79$  (PASTURE & RANGE) 20%

FOR A WEIGHTED AVERAGE

 $CN = 74$  WITH  $AMC II$  $\Rightarrow \underline{CN = 88 \text{ WITH } AMC III}$

# PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF

MISSOURI DAM 10136 JOB NO. 1240-001-1

100 YEAR FLOOD BY REGRESSION EQUATION BY RHK DATE  
HLBV

MISSOURI DAM 10136

100 YEAR FLOOD BY REGRESSION EQUATION

REGRESSION EQUATION FOR THE 100 YEAR FLOOD  
FOR MISSOURI

$$Q_{100} = 85.1 A^{0.939A^{-0.02}} S^{0.576}$$

WHERE :

A = DRAINAGE AREA Sq. Mi.

S = MAIN CHANNEL SLOPE ft./mi.  
(AVG. SLOPE BETWEEN 0.14 AND 0.85L)

FOR MISSOURI DAM 10136

A = 2.88 Sq. Mi.

S = 117 ft./mi.

$$Q_{100} = 85.1 (2.88)^{0.939(2.88)^{-0.02}} (117.0)^{0.576}$$

$$= \underline{3478} \text{ CFS}$$

HEC1DB INPUT DATA



INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

PREVIEW OF SEQUENCE OF STREAM AFTERSHOCK CALCULATIONS

RUNOFF HYDROGRAPH AT 19136  
ROUTE HYDROGRAPH TO 19136  
END OF AFTERSHOCK

.....  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 24 JUL 79  
 .....

RUN DATE: 08/01/88  
 TIME: 07:29:37

DA SAFETY INSPECTION - MISSOURI  
 SPRING LAKE DAM (70-1-17-3)  
 PMP AND 50 PERCENT AVE

JOB SPECIFICATION									
NO	NIP	MDI	ICAD	IHR	IMIN	MTRC	IPLT	IPRT	NSTAN
300	C	5	0	0	0	0	0	0	0
JOPER									
5	0	0	0	0	0	0	0	0	0

MULTI-PHASE ANALYSIS TO BE PERFORMED  
 RELEASE 1 RATE 2 LRIIE 1

RATIOS= 1.00 5.0

# SUB-AREA RUNOFF COMPUTATION

INPUT PRECIPITATION VALUES, RATIOS AND UNIT HYDROGRAPH PARAMETERS

ISTAG	ICDWD	IECON	ITAPE	UPLT	UPPT	INAME	ISTAGE	IAUTC
10100	0	0	0	0	0	1	0	0

## HYDROGRAPH DATA

INPNO	AUNG	PARCA	SWAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.68	0.00	0.88	1.00	0.00	0	1	0

## PRECIP DATA

SPPT	PMS	R12	R24	Q48	Q72	Q96
0.00	24.10	100.00	120.00	150.00	0.00	0.00

## LOSS DATA

LROPT	STARR	DLTKR	RTIOL	ERAIN	STIRK	RTIJK	STRTL	CNSTL	ALSMX	RTIHP
1	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-0.00	0.00	0.00

CURVE NO = 400.00 CNESS = -1.00 EFFECT CN = 00.00

## UNIT HYDROGRAPH DATA

TC= 0.00 LAGE 0.0

## RECESSION DATA

RTIIE= 0.00 RPSSE= 0.00 RTIIE= 1.00

UNIT HYDROGRAPH 21 END OF PERIOD ORIGINATES. TCE = 0.00 HOURS. TAGE = 0.49 VOL= 1.00  
 187. 538. 110. 1839. 238. 2509. 253. 2332. 2012. 1567.  
 1157. 893. 676. 547. 423. 324. 254. 195. 150. 117.



# END-OF-PERIOD FLOW

91. 71. 55. 42. 33. 26. 21. 17. 12. 8.

40.0A	HR.MN	PERIOD	RAIN	CACC	LOSS	COMP Q	END-OF-PERIOD FLOW	40.0A	HR.MN	PERIOD	RAIN	FACE	LOSS	COMP Q
1.01	.04	1	.03	0.03	.01	.01	1.01	12.35	151	.20	.01	.01	.01	2451.
1.01	.10	2	.01	0.30	.01	.01	1.01	12.40	152	.20	.01	.01	.01	3153.
1.01	.15	3	.01	0.30	.01	.01	1.01	12.45	153	.20	.01	.01	.01	3457.
1.01	.20	4	.01	0.30	.01	.01	1.01	12.50	154	.20	.01	.01	.01	3661.
1.01	.25	5	.01	0.30	.01	.01	1.01	12.55	155	.20	.01	.01	.01	3819.
1.01	.30	6	.01	0.30	.01	.01	1.01	13.00	156	.20	.01	.01	.01	3940.
1.01	.35	7	.01	0.30	.01	.01	1.01	13.05	157	.24	.01	.01	.01	4043.
1.01	.40	8	.01	0.00	.01	.01	1.01	13.10	158	.24	.01	.01	.01	4140.
1.01	.45	9	.01	0.00	.01	.01	1.01	13.15	159	.24	.01	.01	.01	4244.
1.01	.50	10	.01	0.00	.01	.01	1.01	13.20	160	.24	.01	.01	.01	4344.
1.01	.55	11	.01	0.00	.01	.01	1.01	13.25	161	.24	.01	.01	.01	4445.
1.01	1.00	12	.01	0.00	.01	.01	1.01	13.30	162	.24	.01	.01	.01	4548.
1.01	1.05	13	.01	0.00	.01	.01	1.01	13.35	163	.24	.01	.01	.01	4754.
1.01	1.10	14	.01	0.00	.01	.01	1.01	13.40	164	.24	.01	.01	.01	4866.
1.01	1.15	15	.01	0.00	.01	.01	1.01	13.45	165	.24	.01	.01	.01	4982.
1.01	1.20	16	.01	0.00	.01	.01	1.01	13.50	166	.24	.01	.01	.01	5037.
1.01	1.25	17	.01	0.00	.01	.01	1.01	13.55	167	.24	.01	.01	.01	5094.
1.01	1.30	18	.01	0.00	.01	.01	1.01	14.00	168	.24	.01	.01	.01	5139.
1.01	1.35	19	.01	0.00	.01	.01	1.01	14.05	169	.30	.01	.01	.01	5167.
1.01	1.40	20	.01	0.00	.01	.01	1.01	14.10	170	.30	.01	.01	.01	5287.
1.01	1.45	21	.01	0.00	.01	.01	1.01	14.15	171	.30	.01	.01	.01	5356.
1.01	1.50	22	.01	0.00	.01	.01	1.01	14.20	172	.30	.01	.01	.01	5464.
1.01	1.55	23	.01	0.00	.01	.01	1.01	14.25	173	.30	.01	.01	.01	5621.
1.01	2.00	24	.01	0.00	.01	.01	1.01	14.30	174	.30	.01	.01	.01	5708.
1.01	2.05	25	.01	0.00	.01	.01	1.01	14.35	175	.30	.01	.01	.01	5952.
1.01	2.10	26	.01	0.00	.01	.01	1.01	14.40	176	.30	.01	.01	.01	6059.
1.01	2.15	27	.01	0.00	.01	.01	1.01	14.45	177	.30	.01	.01	.01	6225.
1.01	2.20	28	.01	0.00	.01	.01	1.01	14.50	178	.30	.01	.01	.01	6374.
1.01	2.25	29	.01	0.00	.01	.01	1.01	14.55	179	.30	.01	.01	.01	6709.
1.01	2.30	30	.01	0.00	.01	.01	1.01	15.00	180	.30	.01	.01	.01	6857.
1.01	2.35	31	.01	0.00	.01	.01	1.01	15.05	181	.18	.01	.01	.01	6851.
1.01	2.40	32	.01	0.00	.01	.01	1.01	15.10	182	.37	.01	.01	.01	6487.
1.01	2.45	33	.01	0.00	.01	.01	1.01	15.15	183	.37	.01	.01	.01	6444.
1.01	2.50	34	.01	0.00	.01	.01	1.01	15.20	184	.35	.01	.01	.01	6595.
1.01	2.55	35	.01	0.00	.01	.01	1.01	15.25	185	.64	.01	.01	.01	6713.
1.01	3.00	36	.01	0.00	.01	.01	1.01	15.30	186	1.56	.01	.01	.01	7212.
1.01	3.05	37	.01	0.00	.01	.01	1.01	15.35	187	2.70	.01	.01	.01	6562.
1.01	3.10	38	.01	0.00	.01	.01	1.01	15.40	188	1.10	.01	.01	.01	10654.
1.01	3.15	39	.01	0.00	.01	.01	1.01	15.45	189	.64	.01	.01	.01	1345.
1.01	3.20	40	.01	0.00	.01	.01	1.01	15.50	190	.35	.01	.01	.01	16307.
1.01	3.25	41	.01	0.00	.01	.01	1.01	15.55	191	.37	.01	.01	.01	16642.
1.01	3.30	42	.01	0.00	.01	.01	1.01	16.00	192	.37	.01	.01	.01	19737.
1.01	3.35	43	.01	0.00	.01	.01	1.01	16.05	193	.38	.01	.01	.01	19737.
1.01	3.40	44	.01	0.00	.01	.01	1.01	16.10	194	.28	.01	.01	.01	18711.
1.01	3.45	45	.01	0.00	.01	.01	1.01	16.15	195	.28	.01	.01	.01	17211.
1.01	3.50	46	.01	0.00	.01	.01	1.01	16.20	196	.28	.01	.01	.01	15237.
1.01	3.55	47	.01	0.00	.01	.01	1.01	16.25	197	.28	.01	.01	.01	13379.
1.01	4.00	48	.01	0.00	.01	.01	1.01	16.30	198	.28	.01	.01	.01	11865.
1.01	4.05	49	.01	0.00	.01	.01	1.01	16.35	199	.28	.01	.01	.01	10644.
1.01	4.10	50	.01	0.00	.01	.01	1.01	16.40	200	.28	.01	.01	.01	9674.
1.01	4.15	51	.01	0.00	.01	.01	1.01	16.45	201	.29	.01	.01	.01	8903.
1.01	4.20	52	.01	0.00	.01	.01	1.01	16.50	202	.29	.01	.01	.01	8304.
1.01	4.25	53	.01	0.00	.01	.01	1.01	16.55	203	.28	.01	.01	.01	7924.
1.01	4.30	54	.01	0.00	.01	.01	1.01	17.00	204	.28	.01	.01	.01	7490.









SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (FOR OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN RATIO	1. RATIO	2. RATIO
				1.00	1.00
HYDROGRAPH AT	1-136	2.49	1	1573%	968%
		( 7.46)		( 558.88)	( 279.44)
ROUTED TO	1-136	2.49	1	1726%	824%
		( 7.46)		( 503.83)	( 251.33)

# SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 757.50 726. 0.	WILLWAY CREST 767.50 726. 0.	TOP OF DAM 772.00 1074. 2650.	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TYPE OF FAILURE HOURS
RATIO OF PIE	MAXIMUM RESERVOIR ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS				
1.00	773.73	1389.	1766.	5.58	15.25	0.00	
.50	773.48	1230.	8169.	2.73	16.25	0.00	



PERCENT OF PMF FLOOD ROUTING  
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 10136  
ROUTE HYDROGRAPH TO 10134  
END OF NETWORK

RUN DATE: 92/01/06  
TIME: 17.29.02.

DAP SAFETY INSPECTION - 415300PI  
SPRING LAKE DAM (MO. 10131)  
PERCENT PWF

JMS SPECIFICATION					
	UNIT	DAY	HK	IN	METRIC
NW	0	0	0	0	0
SW	0	0	0	0	0
SE	0	0	0	0	0
NE	0	0	0	0	0
NT	0	0	0	0	0
LT	0	0	0	0	0
PC	0	0	0	0	0
IPRT	0	0	0	0	0
NSD	0	0	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED  
MPLAN=1 VPIC=5 LATID=1  
01 02 03 04 05 06 07 08 09 10 11 12

**B-28**

SUB-AREA RUNOFF COMPUTATION

INBURY PRECIPITATION VALUES, DATES AND UNIT HYDROGRAPH CHAPTERS

INSTAG	ICOMP	RECON	TYPE	GOLF	JEFF	YOUNG	WATKINS	LAUREN
10136	0	0	0	0	0	1	0	0

HY-5	IUNC	TAREA	SNAP	HYDROGRAPH DATA			PATIO	ISHOW	ISAVE	LOCAL
				YR504	TPST					
1	2	2.68	0.00	3.80	1.00		0.000		1	

	PRECIP DATA			
	R1	R2		
SPFC	120.00	130.00	94R	973
DMC	120.00	130.00	94R	973
SPFC	120.00	130.00	94R	973
DMC	120.00	130.00	94R	973

	STRAK	OLTP	MFIOL	BRAIN	SINKS	RIOOP	STRIL	C-STL	ALPHA	MIMP
	0.8C	3.0C	1.0B	0.0C	0.0C	1.0C	-0.0C	-56.0C	0.0C	0.0C

60096 = AC 13341 001- = 555121 601- = 0013400

HYDROGRAPH DATA  
TC= 0.00 LAG= .03

```
STRTD=          .00      RTDR= 1.00  
         .00      GRCSV= 3.00  
PRECISION DATA
```

NO.04	HR,MN	PERIOD	RATE	FACS	LOSS	COMP @	NO.04	HR,MN	PERIOD	PAIN	EX'S	LOSS	COMP @
END-OF-PERIOD FLOW													

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLUN-FRATTI ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS				
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
HYDROGRAPH AT	1-113	24.4	1	24.7	41.5	43.0	43.0	43.0
	( 7.46)			( 111.72)	( 117.25)	( 122.92)	( 124.34)	( 124.13)
ROUTED TO	1-114	2.8	2	2.1	2.1	2.1	2.1	2.1
	( 0.64)			( 57.11)	( 57.91)	( 58.19)	( 59.33)	( 60.41)

# SUMMARY OF DAM SAFETY ANALYSIS

DATE	ELEVATION OF SPILLWAY TOP	MAXIMUM STORAGE ACFT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
4-25	771.5	1825	2000	0.0	16.58	0.00
4-25	771.5	1825	2217	0.0	16.58	0.00
4-25	771.5	1825	2336	0.0	16.58	0.00
4-25	771.5	1825	2454	0.0	16.58	0.00
4-25	771.5	1825	2572	0.0	16.58	0.00
4-25	772.0	1825	2769	0.25	17.54	0.00

INITIAL JUNE 1975  
 772.0  
 107.0  
 2650

**DATA  
FILM**